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(19) (CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Process and Apparatus for the Wet Purification of Gases

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Notice: This application is as filed and may therefore contain an  
incomplete specification.

**Canada**

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The present invention relates to a process for the wet purification of a gas, which is sprayed with scrubbing liquor as the gas flows in a line, whereafter the resulting gas-liquid mixture is passed through a cyclone separator and  
5 purified gas and contaminated scrubbing liquor are separately withdrawn from said separator, and an apparatus for said process.

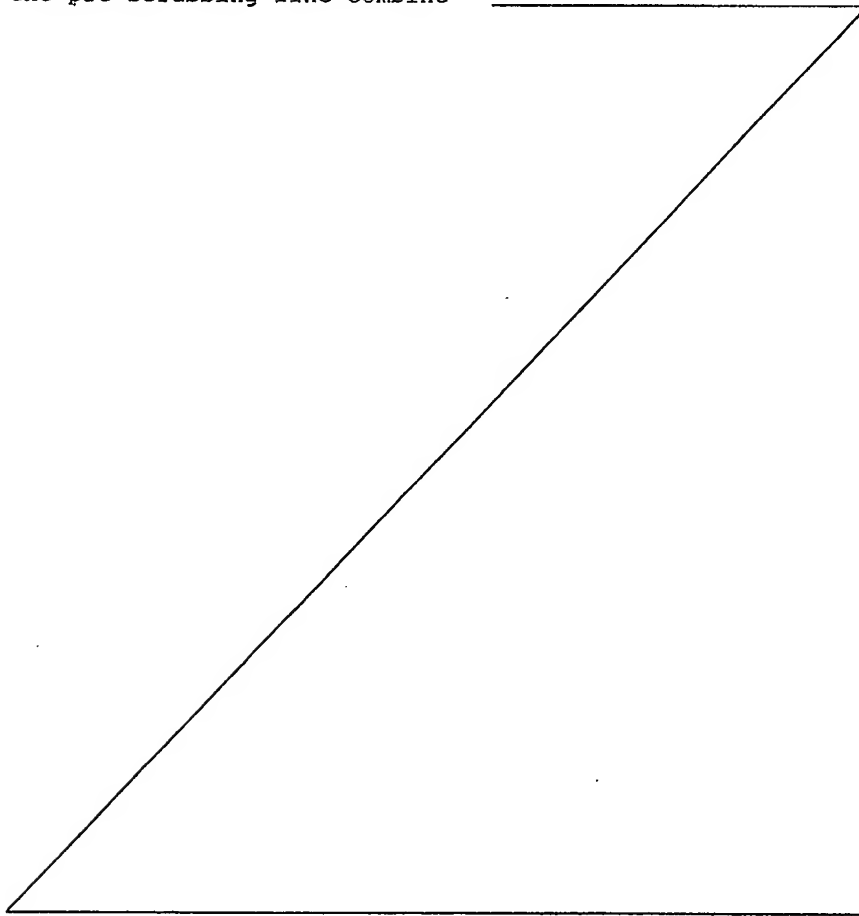
During their wet purification, the gases may be cooled and/or chemically treated.

10 Processes and apparatuses of that kind are known from German Patent 960,452, German Patent Publication 1,300,093; and International Application WO 88/03050. In said cases the lines which are flown through which the gas to be purified flows into the cyclone separator are provided  
15 with means for spraying scrubbing liquor but no care has been taken to effect an optimum contact between the gas and liquid. For this reason it is an object of the invention to provide an improvement in that respect and to purify the gas at low cost. Besides, a soiling of the purifying apparatus  
20 is to be avoided and laden scrubbing liquor is to be discharged from the apparatus on the shortest possible path.

In the process described first hereinbefore that object is accomplished in accordance with the invention in that the gas containing impurities is sprayed with scrubbing  
25 liquid in a pre-scrubbing line, the gas which comes from the pre-scrubbing line and contains scrubbing liquor is passed through a substantially horizontal accelerating line, which at its entrance has a cross-sectional area that is 1.5 to 8 times larger and preferably 2 to 6 times larger than its  
30 cross-sectional area at its exit, additional scrubbing liquor is sprayed into the gas in the accelerating line and the gas-liquid mixture is passed from the accelerating line

into the cyclone separator. The invention provides also an apparatus for carrying out the process.

5 To improve the scrubbing performance and to effect a high degree of separation of the scrubbing liquor in the cyclone separator, the gas is desirably sprayed in the accelerating line with larger liquid droplets than in the pre-scrubbing line. As a result the smaller droplets from the pre-scrubbing line combine



in the accelerating line with the larger liquid droplets in the accelerating line. It is also recommendable to spray the scrubbing liquor at a low velocity from the spraying means into the gas in the accelerating line.

Each of the pre-scrubbing and accelerating lines are provided with at least one sprayer. Each line may readily be provided with more than one sprayer. In most cases it will be sufficient to provide each of the pre-scrubbing and accelerating lines with two sprayers. The scrubbing liquor is preferably sprayed in the accelerating line at a lower rate than in the pre-scrubbing line. To form fine droplets, the sprayers may be supplied with liquid and atomized air.

The substantially horizontally extending accelerating line, which is flown through at high turbulence, must be sufficiently long for the required contact between the gas and liquid droplets. For this reason it is recommendable that its length is 4 to 20 times and preferably 6 to 15 times the diameter of the entrance cross-section of the accelerating duct.

Owing to the direct contact between the gas and liquid in the cyclone scrubber, the temperature of the treated gas is approximately as high as the temperature of the liquid which flows out of the cyclone. If the scrubbing liquor is re-cooled in a heat exchanger it

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will then be possible to cool the gas much more effectively than would be possible, e.g., by an indirect cooling. For this purpose the scrubbing liquor being circulated is recooled in a suitable heat exchanger, e.g., by means of cooling water, before it is sprayed again.

Further features of the process and of the apparatus will be explained with reference to the drawing, in which

Figure 1 is a schematic longitudinal sectional view showing the purifying apparatus and

Figure 2 is a top plan showing the cyclone separator, which is viewed opposite to the direction of the arrow (A) in Figure 1.

The gas, which contains impurities, particularly dust, droplets or undesired gaseous components, flows in the direction of the arrow 1 through a pre-scrubbing duct 2, which is preferably provided with two sprayers 3 and 4. The scrubbing liquor may consist, e.g., of water, which is supplied in lines 5 and 6. Fresh water is added through line 7. The treatment of the gas may also serve to cool and/or chemically change the gas.

The pre-scrubbing duct 2 is succeeded by an accelerating duct 8, the entrance cross-section of which is indicated by the dotted line I and which conti-

nuously tapers as far as to its exit cross-section, which is indicated by the dotted line II. The accelerating duct 8 opens into the cylindrical upper portion of a cyclone separator 10, see also Figure 2, in which the liquid and gas are separated. The purified gas flows off in the direction of the arrow A through the pure-gas line 11. Liquid which contains impurities is collected in the lower portion of the cyclone 10 and flows through the line 12 into a collecting tank 13. In the accelerating duct 8 the gas and the liquid droplets flow at different velocities to improve the contact between the gas and liquid and to facilitate the separation of the multiphase mixture in the cyclone separator.

A major part of the scrubbing liquor is circulated, as a rule. In order to avoid an enriching of solids, the scrubbing liquor can be fed from the collecting tank 13 by the pump 15 through line 14 to a hydrocyclone 16, from which sludge water is withdrawn through line 17. Scrubbing liquor which has partly been purified by the hydrocyclone 16 is recycled in line 5 for a renewed use. The line 5 may include an indirect cooler 9, if desired.

The gas which has been sprayed with liquid in the pre-scrubbing duct 2 is then fed into the accelerating duct 8 and in the latter is again sprayed with scrubbing liquor. For that purpose the two sprayers

20 and 21 are provided. Care is taken that the gas is sprayed in the accelerating duct 8 with larger liquid droplets than in the pre-scrubbing duct 2. This is particularly achieved in that the scrubbing liquor is caused to exit from the sprayer 20 and 21 into the accelerating duct 8 at a lower velocity than from the sprayers 3 and 4 into the pre-scrubbing duct 2. As a result, the rate at which liquid is sprayed into the accelerating duct 8 is 0.2 to 0.6 times the rate at which liquid is sprayed into the pre-scrubbing duct 2.

The inertia of the relatively large liquid droplets in the accelerating duct 8 and the increasing velocity of the gas in the accelerating duct considerably intensify the contact between the gas and liquid and thus improve the purifying performance. Besides, fine liquid droplets coming from the pre-scrubbing duct 2 are collected in the accelerating duct 8 by the large liquid droplets so that the separation of said liquid droplets in the cyclone 10 is improved.

The accelerating duct 8 is provided with at least one intermediate outlet 22, from which collected liquid is conducted in line 23 to the collecting tank 13. That withdrawal of liquid results in a considerable decrease of the loading of the cyclone separator 10 with liquid so that the entraining of liquid droplets into the pure-gas line 11 is also decrea-



sed. The pre-scrubbing duct 2 may also be provided with at least one intermediate outlet 22a for liquid.

#### EXAMPLE

The exhaust gas from a metallurgical plant is purified by an apparatus which is shown in the drawing. The pre-scrubbing duct 2 has a length of 3 meters and is 0.4 meter in diameter. Scrubbing water is sprayed at two points 3 and 4 disposed at the entrance to the pre-scrubbing duct and in the middle thereof. The pre-scrubbing duct is provided with an intermediate outlet 22a for liquid. The accelerating duct 8 is 3 meters long and its rectangular exit opening into the cyclone 10 has a size of 120 x 320 mm. The accelerating duct is provided with sprayers at two points 20 and 21 for scrubbing water, namely, at the beginning and in the middle of the accelerating duct. The cyclone 10 has a height of 3 meters and an inside diameter of 0.5 meter.

Exhaust gas at a temperature of  $84^{\circ}\text{C}$  and at a velocity of flow of 12.3 m/s is fed to the pre-scrubbing duct at a rate of 4340 standard cubic meters ( $\text{sm}^3$ ) per hour. The contents of metal dust and NaOH in the raw exhaust gas are stated in column A of the Table in  $\text{mg}/\text{sm}^3$ :

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	<u>A</u>	<u>B</u>	<u>C</u>
	<u>Raw gas</u>	<u>Pure gas</u>	<u>Scrubbing liquor</u>
As	27.93	0.11	450
Pb	5.56	0.14	165
Sb	2.27	0.28	35
Sn	36.05	0.03	1115
Cu	0.69	0.23	3
Se	0.12	<0.01	14
Te	0.20	<0.01	27
NaOH	534.5	4.2	14200

The spraying stations 3, 4, 20, and 21 succeed each other in the direction of flow (see Figure 1) and have the following data;

	<u>3</u>	<u>4</u>	<u>20</u>	<u>21</u>
Feed pressure of liquid (bars)	4.0	4.0	2.5	2.0
Volume flow rate of liquid (m <sup>3</sup> /h)	14.1	4.8	3.3	3.4
Droplet size range				
minimum (mm)	0.2	0.02	0.02	0.2
maximum (mm)	1.0	0.1	0.1	1.0

Air for atomizing the scrubbing liquor was fed to each of the spraying stations 4 and 20 at a rate of 100 m<sup>3</sup>/h under a feed pressure of 3 bars. The cooler 9

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is not used and the water to be sprayed has a temperature of  $77^{\circ}\text{C}$  in line 6.

The pure gas is at a temperature of  $77^{\circ}\text{C}$  as it leaves the cyclone 10 in the duct 11 and contains the residual impurities stated in column B of the Table (in  $\text{mg}/\text{sm}^3$ ). Under steady-state conditions, the impurities in the water to be sprayed, which is flowing in line 6, are present at the concentrations stated in column C (in  $\text{mg}/\text{liter}$ ).

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A process for the wet purification of a gas, which is sprayed with scrubbing liquor as the gas flows in a line, whereafter the resulting gas-liquid mixture is passed through a cyclone separator and purified gas and contaminated scrubbing liquor are separately withdrawn from said separator, characterized in that the gas containing impurities is sprayed with scrubbing liquid in a pre-scrubbing line, the gas which comes from the pre-scrubbing line and contains scrubbing liquor is passed through a substantially horizontal accelerating line, which at its entrance has a cross-sectional area that is 1.5 to 8 times larger than its cross-sectional area at its exit, additional scrubbing liquor is sprayed into the gas in the accelerating line, and the gas-liquid mixture is passed from the accelerating line into the cyclone separator.

2. A process according to claim 1, characterized in that the gas is sprayed in the accelerating line with larger liquid droplets than in the pre-scrubbing line.

3. A process according to claim 1 or 2, characterized in that the gas is passed through at least one spraying station in each of the pre-scrubbing and accelerating lines.

4. A process according to claim 1 or 2, characterized in that the accelerating line is fed with sprayed liquid at a lower rate than the prescrubbing line.

5. An apparatus for the wet purification of gases, comprising a gas-conducting duct, which is provided with at least one sprayer and opens into a cyclone separator, from which purified gas and scrubbing liquor, which contains impurities, are separately withdrawn, characterized in that the gas-conducting duct consists of a pre-scrubbing duct, which is provided with at least one sprayer, and a succeeding, substantially horizontal accelerating duct, which communicates with the cyclone separator, the accelerating duct is provided with at least one sprayer and the cross-sectional area of the accelerating duct at the entrance for the gas is 1.5 to 8 times larger than the cross-sectional area of the accelerating duct at its exit leading to the cyclone separator.

6. An apparatus according to claim 5, characterized in that the accelerating duct is provided with an outlet for liquid.

7. An apparatus according to claim 6, characterized in that each of the pre-scrubbing and accelerating ducts is provided with at least one sprayer.

8. An apparatus according to claim 5, 6 or 7, characterized in that the accelerating duct has a length which is 4 to 20 times the diameter of its entrance cross-section.

9. An apparatus according to claim 5, 6 or 7, characterized in that the pre-scrubbing duct is provided with at least one outlet for liquid.

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ABSTRACT

For their wet purification, gases flowing in a line are sprayed with scrubbing liquor, the resulting mixture of gas and liquid is passed through a cyclone separator. The gas is initially sprayed in a pre-scrubbing line and the gas which contains scrubbing liquor is subsequently conducted through a substantially horizontal accelerating line having at its entrance a cross-sectional area which is 1.5 to 5 times larger than the cross-sectional area at its exit. The exit of the accelerating line communicates with the cyclone separator. Purified gas is withdrawn from the cyclone separator.

Fig.1

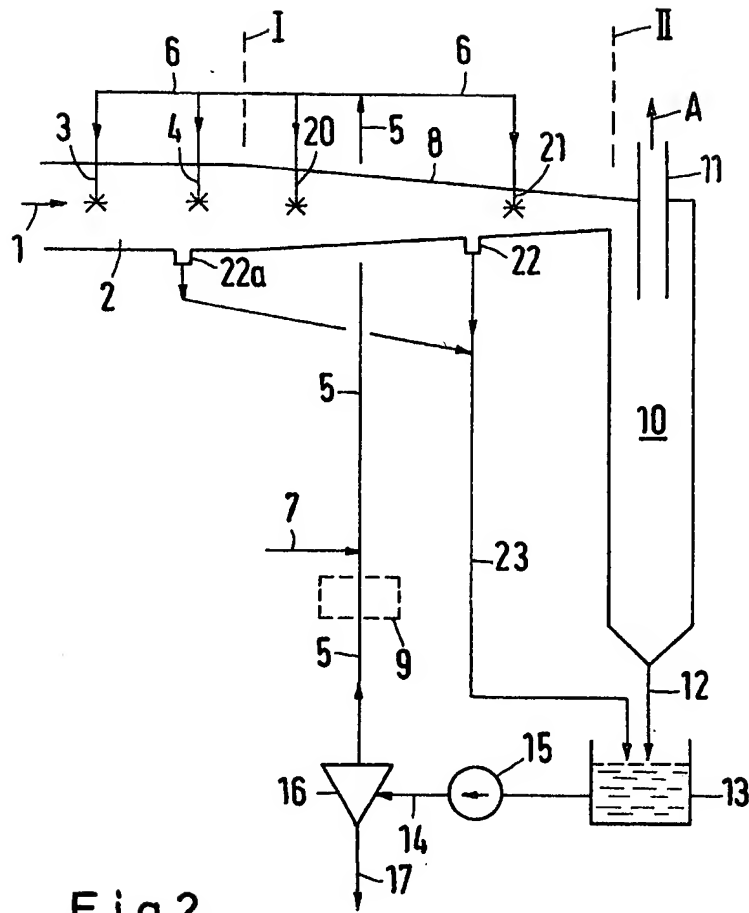


Fig.2

